GEI-4663B

INSTRUCTIONS

PORTABLE OSCILLOGRAPH

TYPE PM-12-A

GENERAL ELECTRIC
SCHENECTADY, N.Y.

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5-43 (300)

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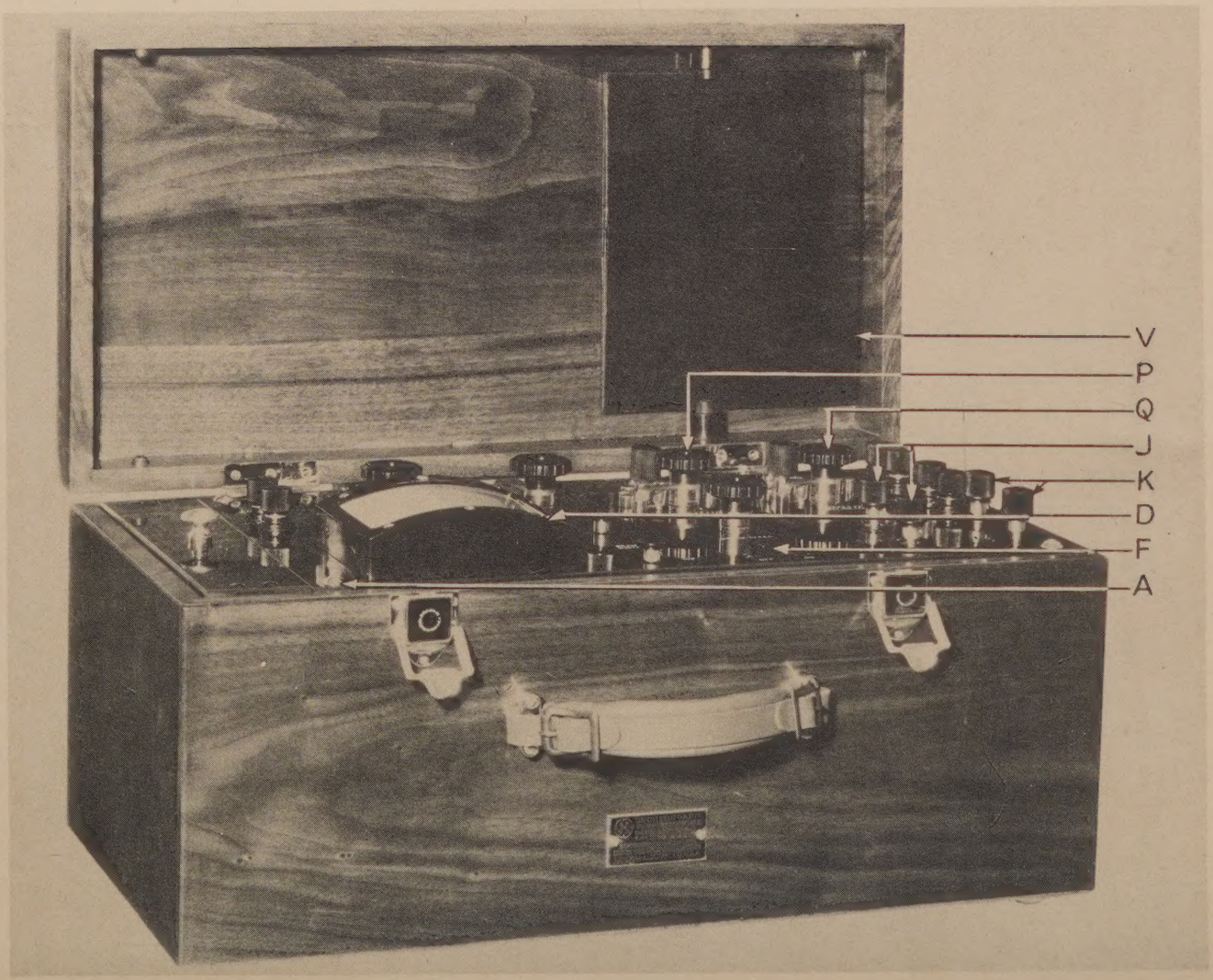

FIG. 1. TYPE PM-12-A OSCILLOGRAPH

PORTABLE OSCILLOGRAPH

TYPE PM-12-A

The following are included as standard equipment with the Type PM-12-A oscillograph:

2 galvanometers
1 spare lamp
1 film holder
1 folding viewing hood
1 roll film
1 box of six galvanometer fuses
1 box of vibrator suspension strips
1 box of vibrator mirrors
1 bottle of damping liquid
1 bottle of mirror cement
1 bottle of soldering flux

The two galvanometers are shipped in their mountings ready for use. They are completely assembled and filled with damping liquid. The spare lamp is mounted in a socket on the bottom of the case. The film holder is shipped in its compartment at the left end of the oscillograph panel. The folding viewing hood is carried inside the oscillograph cover and the remaining supplies with the exception of the film are shipped in the compartment with the film holder.

PRELIMINARY INSPECTION AND ADJUSTMENTS

After unpacking the oscillograph, carefully brush away any dust that may have accumulated on the case and panel during shipment. All adjustments have been made at the factory and it should be possible, if the oscillograph has not been damaged in shipment, to use it immediately as instructed under "Operation." It may be advisable, however, before operating it, to remove it from its case for inspection, for cleaning the optical system and for oiling the bearings. To do this, place the oscillograph on a table and remove the cover; the hinges can be slipped apart for this purpose by pushing the cover to the left after it has been raised. Remove the four round-head screws (A), Fig. 1, at the corners of the panel, and lift the panel from the case by grasping the binding posts at each end. Set the panel on the table in the position shown in Fig. 2. Each galvanometer is clamped in its mounting by means of a knurled screw (B), Fig. 2. These screws should be kept tight at all times. See that the leads are fastened securely to the binding posts on the back of the galvanometers. With a clean soft cloth, polish the front of the lenses in the galvanometers and be careful not to touch them with the fingers thereafter. With a piece of cotton or cloth, polish both sides of the cylindrical lens (C). This can best be accomplished by means of a swab formed by wrapping the cloth or cotton around the end of a lead pencil. Now remove the viewing screen (D) from its place on the panel by pulling upward, and carefully polish the surface of the oscillating mirror (E). If oil has accumulated on the mirror, it should be carefully cleaned off with a cotton swab moistened with carbon tetrachloride or gasoline, and polished afterward.

Before placing the oscillograph back in its case, it will be well to adjust the positions of the galvanometers and to check the adjustments of the optical system. To do this, connect the terminals marked 110 V., 50-60 cyclesto any 110-volt, 50- to 60-cycle alternating-current lighting circuit, and throw the switch (F) on the ON position. Turn the knob marked MOTOR SPEED to the extreme left to prevent the motor from running and turn the lamp on by moving the switch marked LAMP to the position marked 1. Turn the shutter control knob first to the SET and then to the OPEN position, and rotate the disc shutter (G), Fig. 5 and 8, by hand until a beam

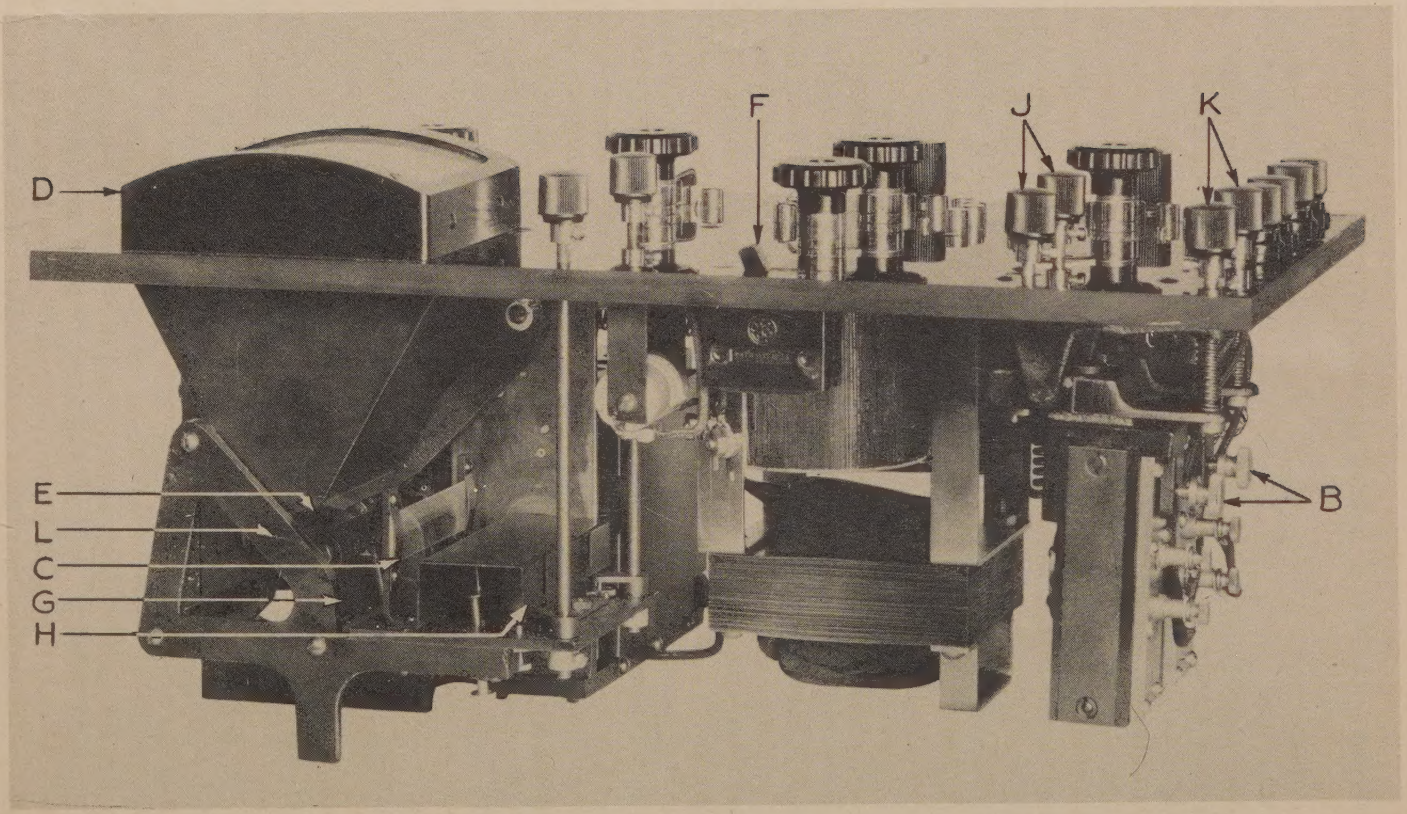

FIG. 2. TYPE PM-12-A OSCILLOGRAPH
REMOVED FROM ITS CASE

of light shines out from the end of the prism housing (H), Fig. 2. Open each aperture as wide as possible by turning the knobs marked BEAM WIDTH to the extreme left. A brilliant image of the lamp filament will now appear on the front of each galvanometer if the prisms are properly adjusted. These images should be located so that the small mirror in each galvanometer is approximately in the center of the spot of light. If the light spots do not fall on the mirrors, the prisms must be adjusted according to the instructions under the heading "Prism Adjustment."

If the prisms are in proper adjustment, each galvanometer mirror will reflect a small beam of light, and each galvanometer should be moved in its mounting by means of the knobs (J) and (K), Fig. 2, until these beams fall approximately through the center of the cylindrical lens (C). Each galvanometer lens will also reflect a beam of light that should not be confused with the beam from the mirror. The beam from the mirror is narrow and elongated, and is an image of the aperture, while the beam from the lens surface is circular in shape. The lens has been tilted properly in its mounting so that these two beams will not coincide. The beams may be easily located if the adjustments are made in a room that is somewhat darkened.

When the beams from the galvanometer mirrors are adjusted to fall upon the center of the cylindrical lens (C), two brilliant spots of light will appear on the viewing screen. These should be narrowed down to small spots by turning the BEAM WIDTH controls on the panel. These are the spots that trace the curves, and they may be moved at will from the top of the screen to the bottom by turning the knobs (J), or along the screen from left to right by turning the shutter disc (G), Fig. 5 and 8. Now start the motor by turning the knob marked MOTOR SPEED to the extreme right, and after it has started, turn the knob again toward the left to prevent it from running too fast. Each spot of light should now trace a narrow but brilliant line across the screen from left to right, and the lines should extend completely to the ends of the screen.

The oscillograph should now be ready for operation, but before placing it back in the case, the moving parts should be oiled with a good grade of light machine oil. The oil can best be applied with a piece of wire that has been flattened on one end, and the places that should be oiled are the following:

(1) One bearing at each end of oscillating mirror shaft, one of these is shown at (L), Fig. 2.

(2) Three bearings in the link mechanism that transmits motion from the cam to the oscillating mirror.

(3) The oiler that provides lubricant for the cam. This oiler is shown at (M) in Fig. 5. Several drops of a heavy oil should occasionally be placed in the small cup (N). Vaseline is especially recommended for this purpose, and it can be introduced into the cup without removing the motor unit by melting it and dropping it in with the flattened wire. Each time this cup is filled, the adjustment of the oiler should be checked according to instructions under the heading "Periodical Oiling."

Now carefully place the oscillograph back in the case and fasten it down with the four round-headed screws.

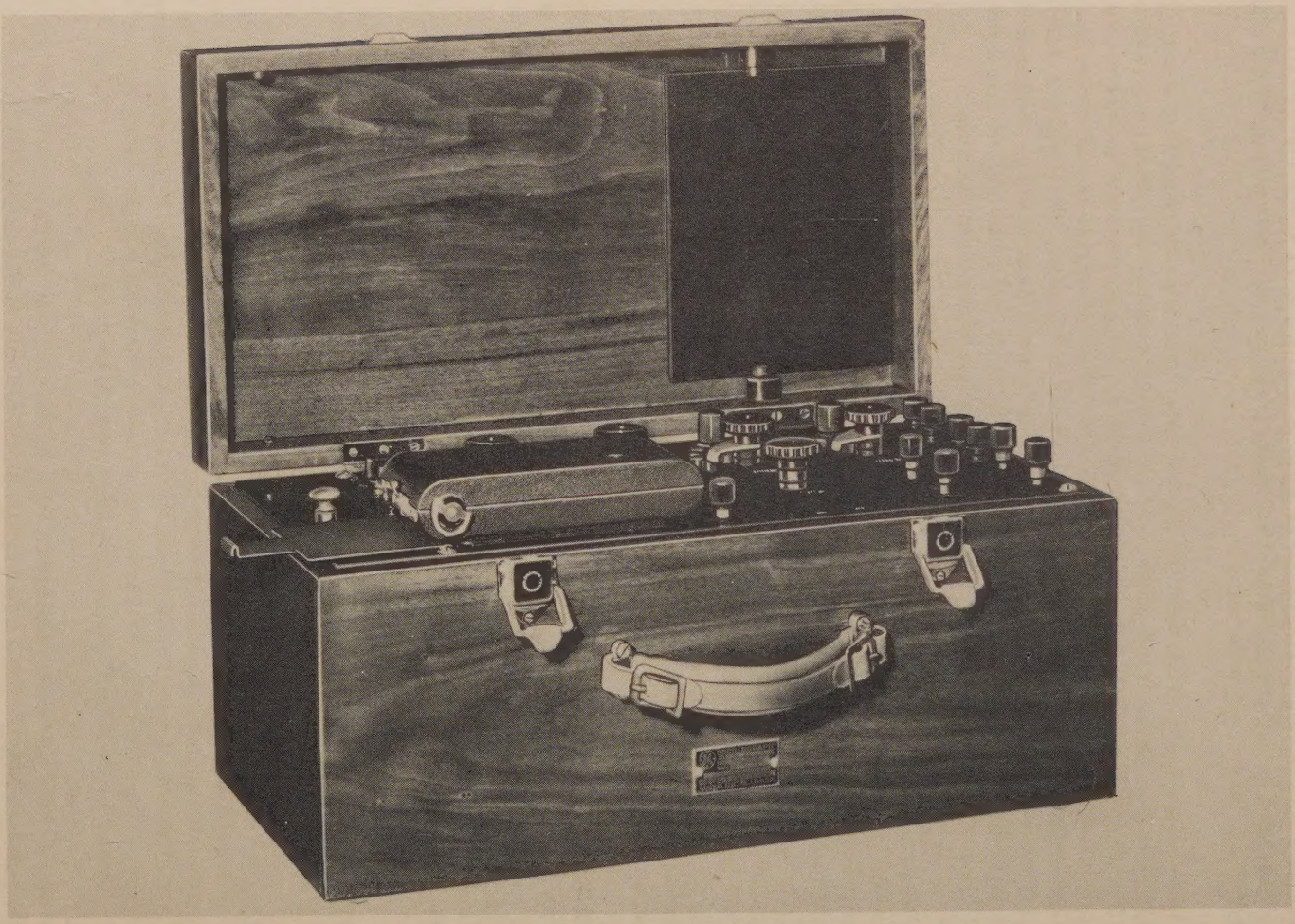

FIG. 3. TYPE PM-12-A OSCILLOGRAPH
WITH FILM HOLDER IN PLACE

OPERATION

To place the oscillograph in operation, connect the binding posts marked 110 V., 50-60 cycles, to any 110-volt, 50- to 60-cycle alternating-current lighting circuit and the voltage and current whose wave-shapes are to be observed to the binding posts marked POTENTIAL GALV. and CURRENT GALV., respectively; but before doing this, be sure that switch (F), Fig. 1, is off and that the galvanometer rheostats (P) and (Q) are each on their "OFF" button.

The voltage applied to the POTENTIAL GALV. terminals should not exceed 250 volts, and the current through the CURRENT GALV. terminals should not exceed 7 amperes, both of the above being root-mean-square or effective values. Now be sure that the shutter is open by turning the knob marked SHUTTER to SET and then to OPEN. Then turn knob marked LAMP to position 1, throw the switch to ON, and bring the motor to speed by turning the knob MOTOR SPEED to the extreme right. After the motor has started, turn the knob about one-half revolution back to the left to prevent the motor from running too fast. By means of knobs (J), Fig. 1, move the zero lines on the viewing screen to the position desired. It is usually best to place them both in coincidence with the black line across the screen so that it can serve as an X-axis. Now close the galvanometer circuits and adjust the amplitude of the waves to their desired values by means of the galvanometer rheostat knobs (P) and (Q) and adjust the motor speed until the waves on the screen are stationary. The number of complete cycles visible depends on the speed of the motor and is, therefore, under the operator's control, although it is usually best on 60-cycle circuits to run the motor at a speed that produces a curve a little over one cycle in length. This corresponds to a motor speed of 1800 revolutions per minute, and it is not advisable to run it faster than this, although it may be used at slower speeds if desired.

On the same shaft with the variable-speed motor, which drives the rotating shutter and oscillating mirror, is a synchronous motor for synchronizing the movement of these with the line frequency. By means of the synchronous motor either one or two cycles of a 60-cycle wave may be held stationary on the viewing screen.

If it is desired to use the synchronous motor, throw the switch marked SYN. MOT. to ON and then adjust the speed of the driving motor until the mechanism falls into step. It should fall into step with approximately 1-1/4 cycles or 2-1/2 cycles appearing on the viewing screen if the frequency of the circuit is 60 cycles. After synchronizing, no further adjustment of speed should be necessary unless variations in line voltage are very great.

After the waves have been made stationary, adjust knobs (K), Fig. 1, until the waves are of maximum brilliancy. It should not be necessary to move these adjustments again unless the galvanometers are moved or changed in their mountings.

The positive direction of the time axis on the screen is from left to right so that if the two galvanometers are connected in their circuits correctly, the two waves will appear on the screen in their proper phase relation to each other. If one is reversed with respect to the other, the angle between the two waves will be the correct angle plus or minus 180 degrees. If it is known that the phase angle is less than ninety degrees, as is usually the case, there can be no danger of an erroneous result in its determination due to a reversed connection, as this will make the angle appear greater than ninety degrees. However, if nothing is known in regard to the phase relation, care must be taken to see that the galvanometers are connected correctly in their circuits. The instantaneous relative polarity of the terminals in this case should be determined by connecting the galvanometers in series in such a way that the two waves on the screen coincide.

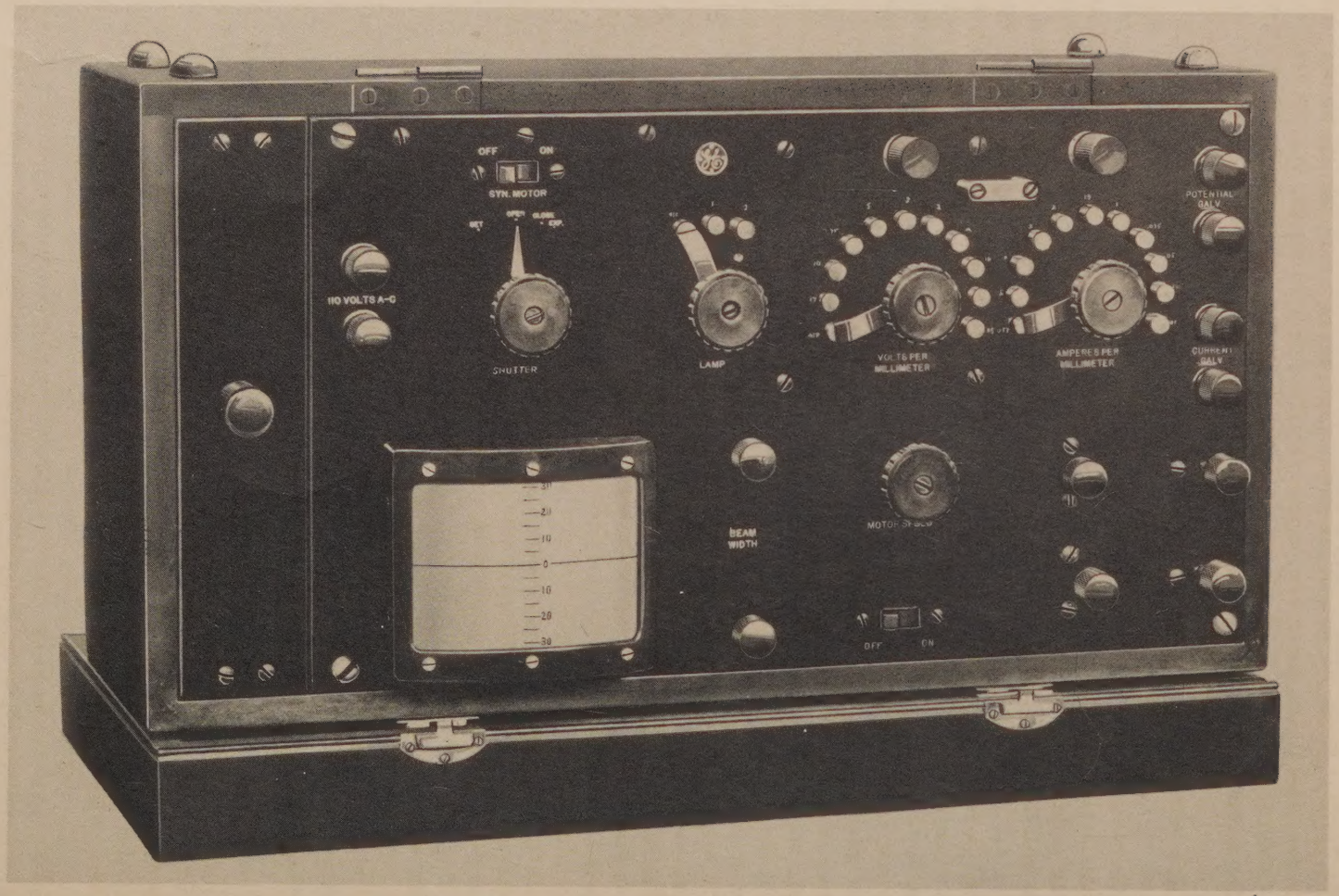

FIG. 4. TYPE PM-12-A OSCILLOGRAPH
IN VERTICAL POSITION

The two terminals that are tied together in the series connection will then be of opposite instantaneous polarity.

This oscillograph may be used to record simultaneously two voltages or two currents. To use the current galvanometer for recording potential, remove link (R), Fig. 8. This opens the internal shunt across the galvanometer. (See connection diagram, Fig. 13). Insert suitable external resistance in series with this galvanometer (approximately 30 ohms per volt applied), turn the galvanometer rheostat to the extreme right and then adjust the external resistance to give the desired deflection.

To use the potential galvanometer for recording current, turn the potential galvanometer rheostat to the extreme right. Use an external shunt and connect its drop circuit to the potential galvanometer terminals. Approximately 30 ohms per volt drop should be connected in series with the galvanometer. This may be later adjusted to give the desired deflection.

The waves as seen on the screen may easily be photographed at any time for preservation or analysis, with the film holder that is found in the compartment to the left of the panel. The film holder should be loaded with standard 2-1/4 in. by 3-1/4 in. non-autographic roll film in the same manner as an ordinary camera. Be sure, however, that the film passes under the small rolls at the ends of the transparent cylindrical surface. After the end of the paper has been started on the rewinding spool, replace the cover, make sure that the slide is completely closed, wind the film through until the Fig. "1" is directly below the red window, remove the viewing screen D, Fig. 2, and place the film holder over the opening in the panel in place of the viewing screen as shown in Fig. 3. Then turn the shutter knob to CLOSE, and move the LAMP switch to position 2, increasing the brilliancy of the lamp. Hold the film holder down on the panel, withdraw the slide as far as possible, and move the shutter knob to the position EXP. Release it after holding it in this position for a moment, close the slide in the film holder, and move the LAMP switch back to position 1. To open the shutter again for visual use, move the SHUTTER knob again to SET and then to OPEN. It is not necessary for the curves on the screen to be stationary when a photograph is taken because the shutter is automatically controlled by the oscillating mirror mechanism in such a way as to permit the beams of light to trace the curves on the film surface only once. Eight oscillograms may be taken on one roll of film. Turn the film to the next number after each record is taken as in a camera.

Since the oscillograph will operate in any position, it may be placed with the panel in a vertical position as shown in Fig. 4, and if the room is sufficiently darkened, the waves can then be seen by a large audience. If it is necessary to operate the oscillograph in a very light room, the screen should be shielded with the folding viewing hood (V), Fig. 1.

OPTICAL SYSTEM

The optical system has been adjusted at the factory and should require no further adjustments than can be made with the panel controls if the oscillograph is handled with reasonable care. However, if the waves as traced on the screen become of less brilliancy or sharpness than normal, the optical system should be checked according to the instructions under "Preliminary Inspection and Adjustments."

If the light beams on the galvanometers are not symmetrically located with respect to the galvanometer mirrors when the apertures are wide open, the prisms should be adjusted until this condition is obtained.

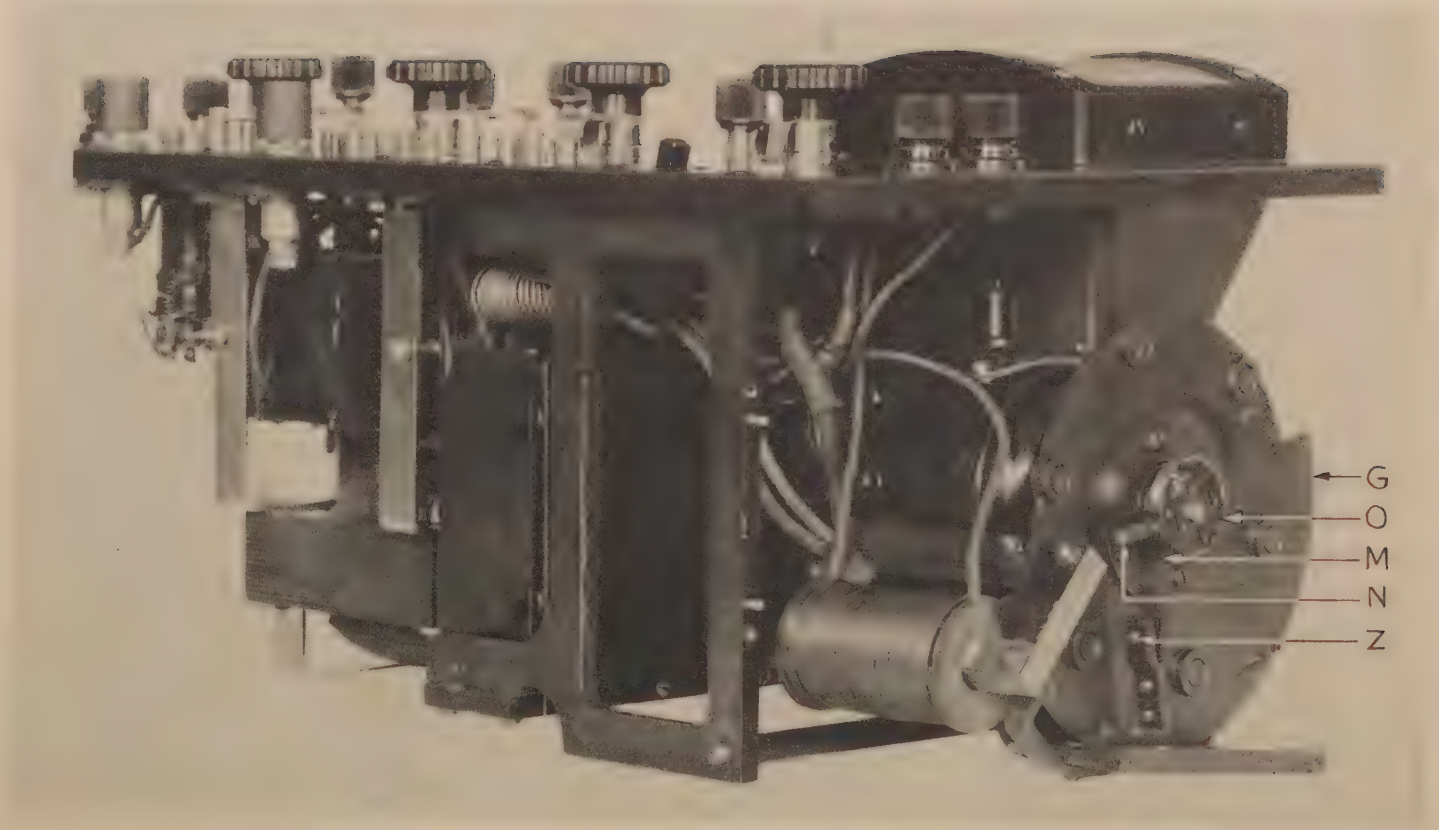

FIG. 5. TYPE PM-12-A OSCILLOGRAPH
WITHOUT CASE. MOTOR UNIT REMOVED FROM MOUNTING

PRISM ADJUSTMENT

Each prism is supported by a ball that is clamped in a socket on the under side of the prism housing. Each ball is clamped firmly in place by three screws (R), Fig. 6, which surround it and the adjustment handle (S).

If it is necessary to adjust the position of a prism, loosen very slightly each of the three clamping screws and carefully move the prism by means of the handle (S) until the beam is centered on the galvanometer mirror. Now tighten the three screws again, thus clamping the prism in its new position.

If one beam appears to be more intense than the other, it may be that one of the prisms is not properly located in the light beam from the lamp housing, or that one prism is casting a shadow on the other. This may be corrected by loosening the screws (T) and sliding the prism mountings until an intense beam is thrown on each galvanometer.

LAMP

The oscillograph is designed to use a 32-candle-power, 6-volt automobile headlight lamp, Mazda No. 1133L, with the standard single-contact bayonet base. The Mazda No. 1133 is satisfactory but has a shorter life. A 21-candle-power lamp may be used if desired in an emergency, although the curves produced will not be so brilliant.

The lamp can be replaced after removing the two knurled screws (U), Fig. 8, and taking off the cover to the lamp housing.

CLEANING THE OPTICAL SYSTEM

The whole optical system, including all lenses, prisms and mirrors must be kept clean. Brilliant lines and good photographic records cannot be obtained unless this is done. The galvanometer lenses, the cylindrical lenses, and the oscillating mirror should occasionally be polished according to the instructions under "Preliminary Inspection and Adjustment." The prisms should also be cleaned occasionally. This can best be done by taking out the two screws (T), Fig. 6, and removing the entire prism and its mounting. Then carefully clean the prism with a piece of cotton moistened with carbon tetrachloride, or gasoline, taking care not to loosen it from its mounting. It will be necessary to adjust it again after putting it back in place.

THE GALVANOMETERS

The galvanometers have been adjusted, filled with damping liquid, and sealed at the factory, and should require no attention whatever except in the case of accidental injury. Extreme care should always be exercised to prevent galvanometers from coming in contact with each other or with large pieces of iron or steel when removed from the oscillograph as such treatment may demagnetize the permanent magnets and reduce the sensitivity.

GALVANOMETER EXCHANGE SERVICE

An exchange service is available whereby damaged galvanometers may be replaced by factory-repaired and adjusted galvanometers. A galvanometer sent for repairs should be addressed to the General Engineering Laboratory, General Electric Company, Schenectady, N. Y.

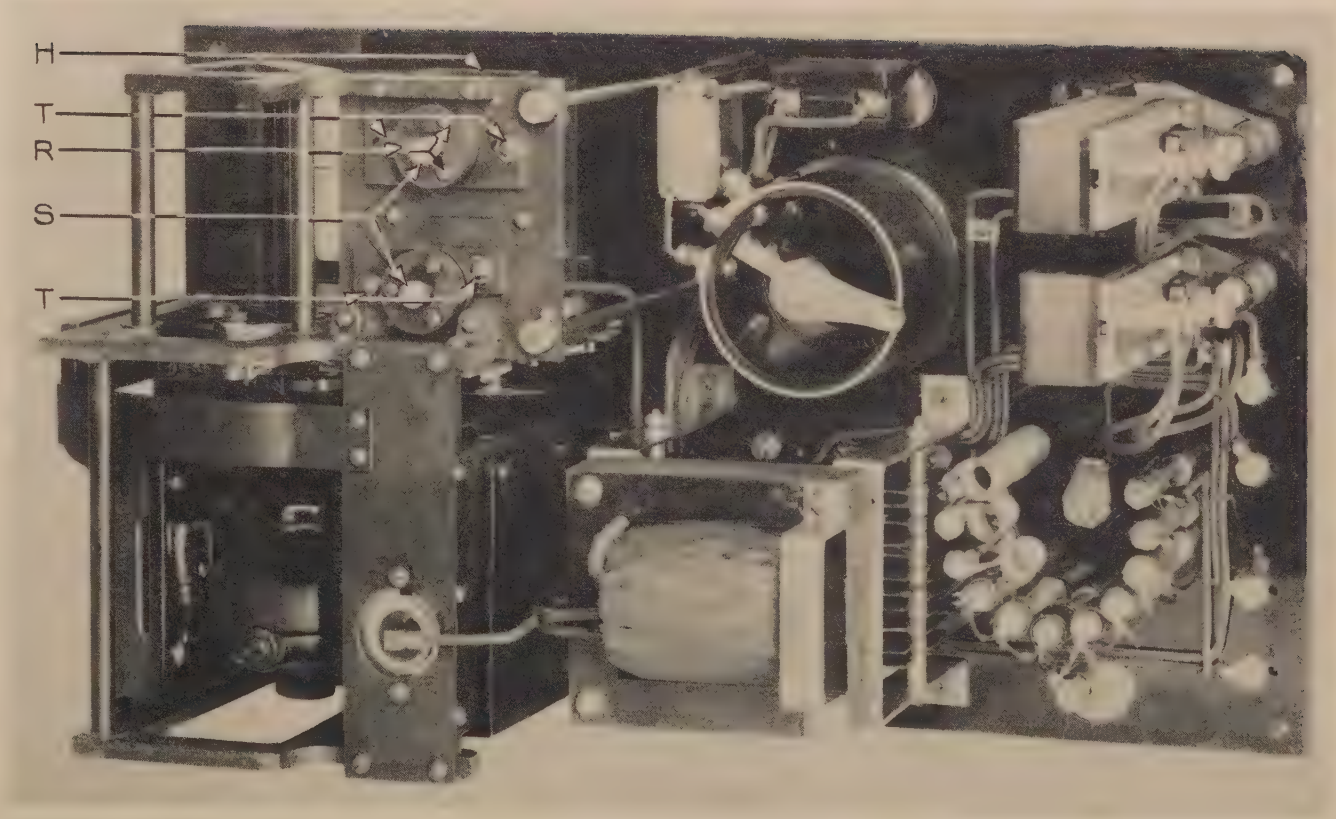

FIG. 6. TYPE PM-12-A OSCILLOGRAPH
SHOWING LOWER SIDE OF PANEL

The replacement galvanometer will be shipped at once by parcel post C.O.D. Care should be exercised when packing galvanometers for shipment to keep them well separated.

REPAIRING A DAMAGED SUSPENSION

The only part of an oscillograph galvanometer that is likely to become damaged by ill treatment is the suspension or moving element which consists of a loop of fine metallic ribbon stretched tightly between two ivory bridges and a small mirror cemented to the loop mid-way between the bridges.

To replace a damaged suspension, lay the galvanometer with its lens downward on a table and remove the eight screws on the back. Then remove the back plate by pulling straight upward on the binding posts. If the plate sticks, it may be loosened by inserting the point of a small screwdriver in the recess at each end and prying upward.

After removing the back plate and the vibrator element that is attached to it, transfer the damping liquid to a clean receptacle and carefully examine both it and the interior of the galvanometer cell for pieces of the old suspension. If the damping liquid is clean and all pieces of the old suspension are removed, it may be used again, but if it appears dirty, new liquid should be used.

Now clean the vibrator element in carbon tetrachloride or gasoline and lay it across two blocks of wood or other supports with the binding posts downward, or clamp the element lightly in a small vise. Solder one end of a suspension strip that is supplied with the oscillograph to the lower pin (V), Fig. 7, using a small, clean, sharp-pointed soldering iron and the special flux supplied for the purpose. With the pulley toward you, lay the strip flat in the left slot in each of the two bridge supports. Pass it over and around the pulley without twisting it, and then back through the slots in the right of the bridges. Pull the strip until the lever carrying the pulley is exactly vertical, and then solder it to pin (W). Cut off the excess strip. Apply a little mirror cement to the strips exactly mid-way between the bridges, and place one of the mirrors on the cement with its reflecting side upward. The mirror can best be handled by sticking it to the end of a moistened toothpick. Press the mirror down gently and evenly with the end of a toothpick, being careful to keep the mirror centrally located on the strips and with its long edges parallel to them Then with the toothpick, apply a little more cement to the back of the suspension strips below the mirror, and place the vibrator element in a place where it will not collect dust and let it remain there for four or five hours before placing it back in the damping liquid. If it is necessary to use the galvanometer immediately, the cement can be dried rapidly by holding a warm iron near the mirror but not touching it. If the mirror is not perfectly clean the reflecting surface should be polished after the cement has thoroughly dried, by gently rubbing it with a toothpick moistened in acetone.

Before placing the vibrator back in the cell, the cavity should be filled with damping liquid again to about one-quarter inch below the outside surface. The vibrator element can be replaced in only one position because one dowel pin is larger than the other. Be sure to tighten the screws equally.

CALIBRATION OF GALVANOMETERS

After a galvanometer has been restrung, it is necessary to adjust its sensitivity again to the standard value if the calibrations on the current and potential galvanometer rheostats are

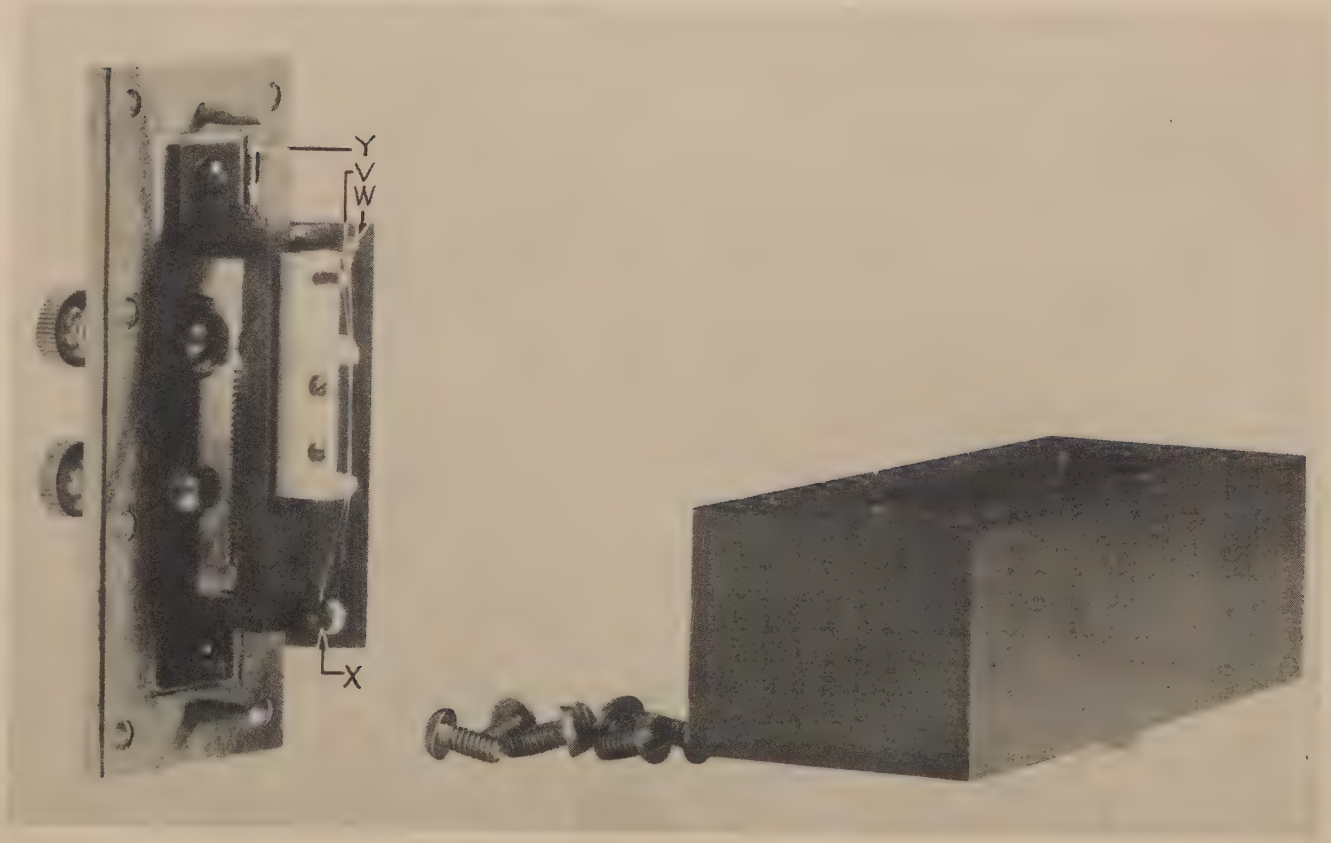

FIG. 7. VIBRATOR FOR TYPE PM-12-A OSCILLOGRAPH GALVANOMETER, REMOVED FROM CELL BOX

to be used without a correction factor, although if the suspension is mounted so that the pulley lever (X), Fig. 7, is vertical and if the tension nut (Y) is not moved, the calibration will be approximately correct.

The calibration of the potential galvanometer can be checked by applying a known d-c. voltage to the POTENTIAL GALV. terminals, and comparing the deflections on the screen with the quotient obtained by dividing the applied voltage by the volts-per-millimeter factor indicated by the galvanometer rheostat. The calibration of the current galvanometer can be checked in a similar way with a known direct current through the CURRENT GALV. circuit. The calibration values engraved on the panel apply only when galvanometers, Cat. 3859770G3, are used. It is necessary for the user to recalibrate if galvanometers of other types are substituted.

The deflection of either galvanometer may be increased or decreased by loosening or tightening, respectively, the knurled tension nut (Y), Fig. 7. When the galvanometers are adjusted to standard sensitivity, a current of 60 milliamperes through the galvanometer will produce a 30-millimeter deflection on the screen. The suspension then has a natural undamped frequency of about 3000 cycles per second and may be used to record, without correction, frequencies as high as 1000 to 1500 cycles per second.

FUSES

The fuses in the galvanometer circuits will protect the galvanometers, Cat. 3859770G3, normally furnished, from damage due to the accidental application of excessive current except in some cases where the current is many times normal and is suddenly applied to the galvanometer circuit.

The fuses are located in holders on the panel directly back of the galvanometer rheostats. They may be removed by unscrewing the insulated caps which cover them. These caps should not be screwed down tighter than necessary to hold the fuses firmly in place. No fuses should be used in these holders except those supplied for the purpose.

PERIODICAL OILING

The two oscillating mirror bearings and the three bearings of the link mechanism that transmits motion from the cam on the motor shaft to the oscillating mirror should be oiled frequently with a good light machine oil. The oil can be easily applied to the bearings with a small wire flattened at one end as explained in "Preliminary Inspection and Adjustments."

The cam surface is continuously lubricated by means of the oiling pad shown at (M) in Fig. 5. Once in each revolution, the high point of the cam touches this pad and collects a small quantity of oil. The cup (N) should be filled with vaseline occasionally. This can be done easily without removing the motor, by melting the vaseline and dropping it in the cup with the flattened wire. The screw (Z), Fig. 5, is for the purpose of adjusting the position of the oiling pad (M) with respect to the cam (O). This adjustment should be checked occasionally, as the pad surface may in time wear away. The pad should be adjusted so that it is lightly touched by the high point of the cam. Note that the adjusting screw (Z) can be reached with a screwdriver without removing the motor unit.

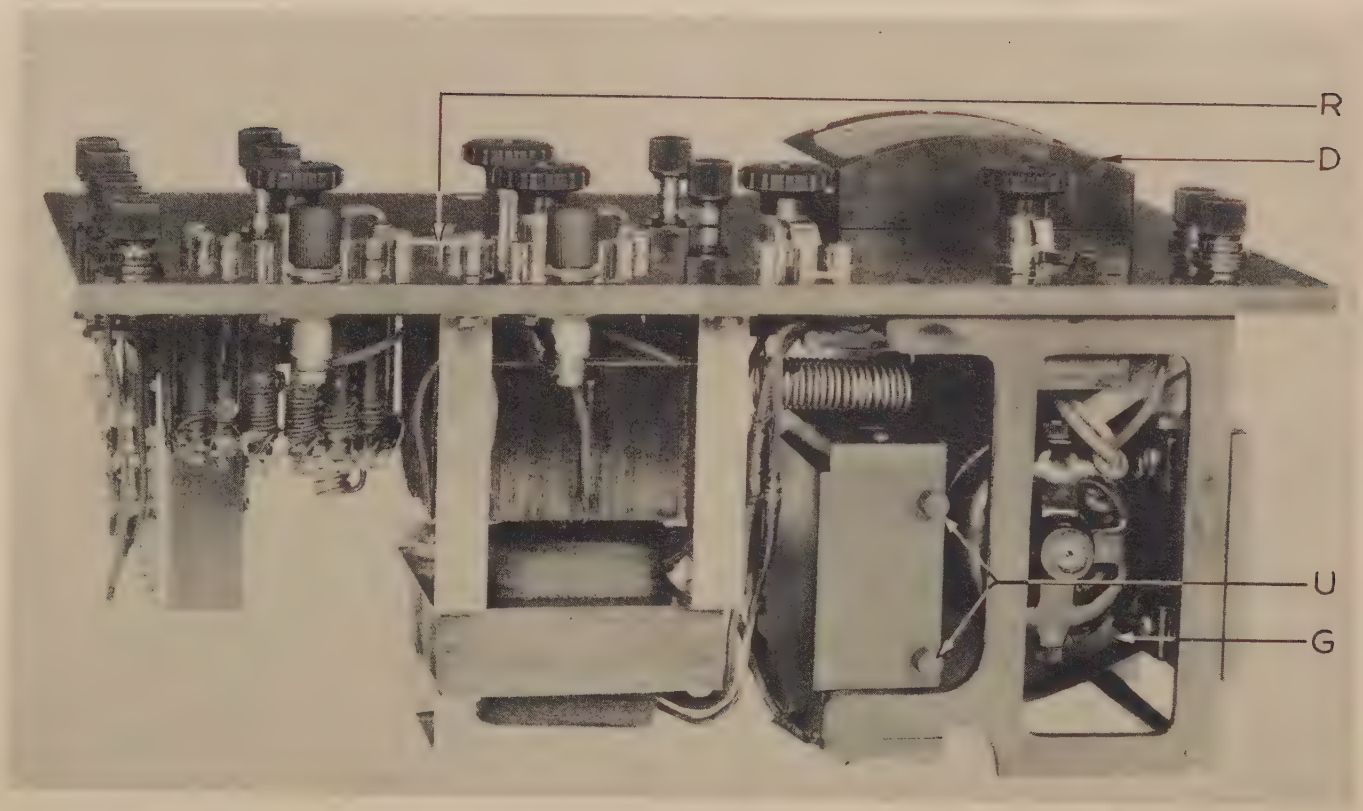

FIG. 8. TYPE PM-12-A OSCILLOGRAPH
WITHOUT CASE

The motor bearings should be oiled occasionally but it is not necessary to do this as frequently as the above. An oil hole is provided in each bearing, and these can be reached with the flattened wire if the oscillograph is removed from its case and placed on end with the motor downward. A small oil can with a long spout may also be used for this purpose.

CONTINUOUS-DRIVE FILM HOLDER

This film holder, which is furnished as optional equipment, is shown in its operating position in Fig. 9, and along with its auxiliary mirror in Fig. 10.

Turn the rheostat handle marked MOTOR SPEED counterclockwise as far as possible. This opens the armature circuit of the motor inside the oscillograph case and makes sure that the rotating shutter will not cut off the light while making a record. Remove the viewing screen from the oscillograph and carefully place the auxiliary mirror inside the light shield above the oscillating mirror so that the light beams from the galvanometers will strike it.

Remove the bottom plate (A), Fig. 12, from the film holder and place it in position over the opening in the oscillograph panel so that the pins which engage with catch (B) will be to the left. With the oscillograph lamp lighted, the reflected beams from the galvanometers should now strike the cylindrical lens (C). If the beams do not strike the middle of this lens, it may be adjusted by loosening the three screws (D) and shifting it to the proper position.

The motor is mounted on the top of the film holder, and change gears shown in Fig. 11 are provided to give five different film speeds. The lowest film speed is obtained with the gears assembled as shown in this illustration. This gear ratio runs the film through in approximately 35 seconds. This low speed is desirable for recording slow transients, especially in d-c. circuits. By interchanging the two gears, the film may be run in about 2-1/2 seconds. This will give 5 cycles per inch of a 60-cycle wave on the record, which will show wave shapes and phase relations as well as maximum values. The film holder is normally furnished with the gears assembled for this film speed. By using the other gears shown in the photograph, intermediate speeds are provided by which the complete film can be exposed in approximately 4, 9 or 20 seconds.

This film holder uses the same film as that used in the magazine film holder furnished with the oscillograph, which is any standard 2-1/4 in. by 3-1/4 in. non-automatic roll film. Place the film between its pivots (E), Fig. 12, run the paper over the rollers (F) and start it on the reroll spool (G). Now place this spool in position between its pivots. Replace plate (A) on the film holder and set the film holder in position on the oscillograph as in Fig. 9. Connect the leads from the motor to the same terminals on the oscillograph panel to which the power supply has already been connected for operating the oscillograph. It is not necessary to place the lamp switch on position 2, especially for slow speed records. With the galvanometer circuits adjusted, close the switch in the motor circuit and allow sufficient time for the film to run through. Stop the motor and remove the film for developing. Any standard developer for photographic films may be used.

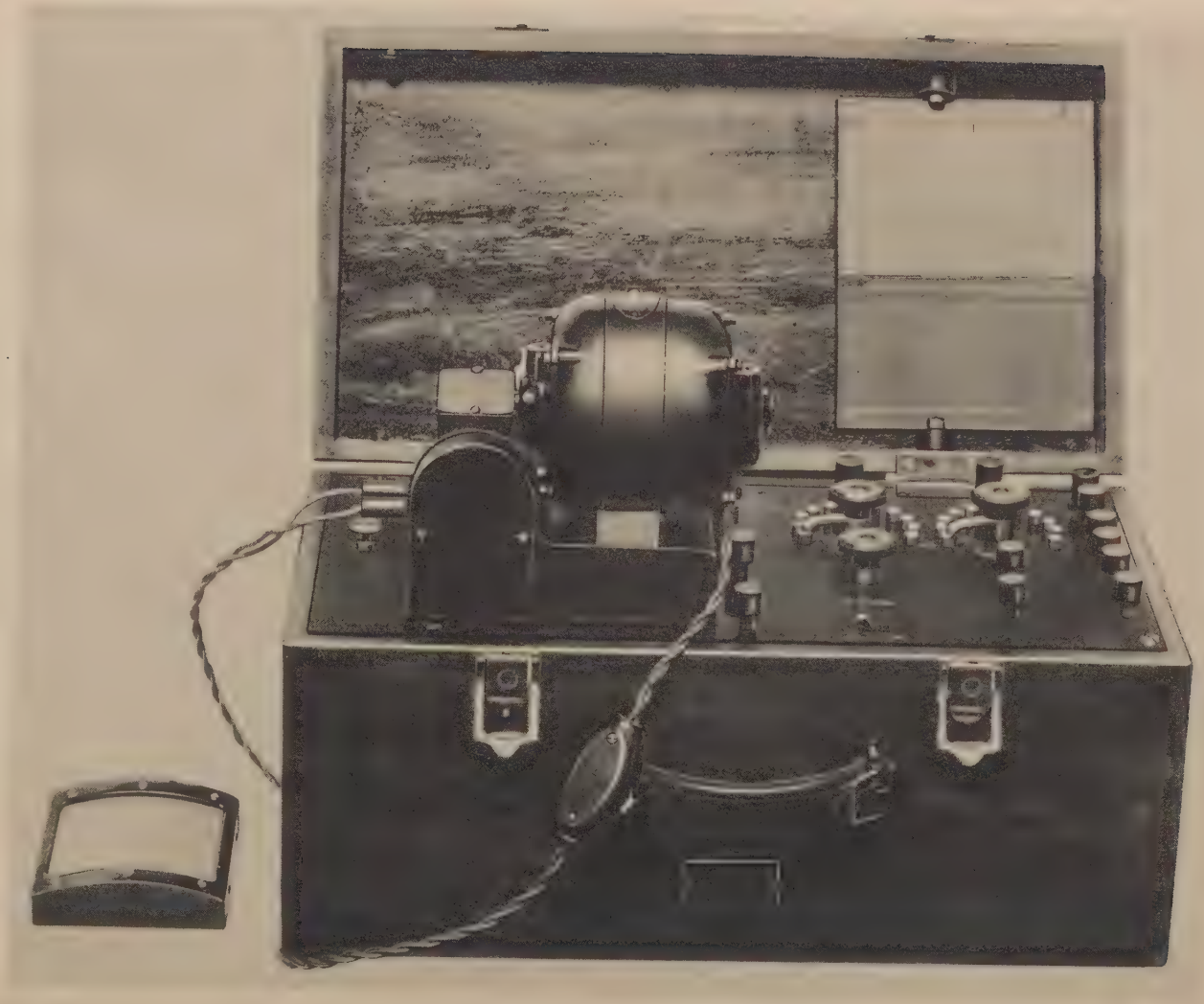

FIG. 9. TYPE PM-12-A OSCILLOGRAPH
WITH CONTINUOUS-DRIVE FILM HOLDER IN PLACE

SUPPLIES

Unless otherwise specified, the following supplies must be obtained from the General Engineering Laboratory, General Electric Company, Schenectady, New York, by marking the order "Oscillograph Supplies."

LAMP

Mazda No. 1133L, 32 cp., 6 to 8 volts, single-contact, bayonet base, automobile headlight lamp. Mazda No. 1133 lamps, which are satisfactory except for shorter life, may be obtained from local dealers in automobile supplies.

FILM

Either Eastman No. 120 non-autographic eight-exposure roll film, or Agfa-Ansco No. B-2 eight-exposure roll film may be used. These may be obtained from local dealers in photographic supplies.

FUSES

Specify Cat. No. GE2548 fuses for use with galvanometers, Cat. 3859770G3. These are furnished in boxes of six each.

DAMPING LIQUID

Specify damping liquid for PM-12 oscillograph galvanometers, Cat. 3859770G3. This is furnished in two-ounce bottles. Two ounces is sufficient for filling four galvanometers.

SUSPENSION STRIPS

Specify suspension strips for PM-12 oscillograph galvanometers, Cat. 3859770G3. These are furnished in standard packages of one dozen each.

MIRRORS

Specify mirrors for PM-12 oscillograph galvanometers, Cat. 3859770G3. These are furnished in standard packages of one dozen each.

MIRROR CEMENT

Specify mirror cement for oscillograph galvanometers. This is furnished in 1/8-oz. bottles.

SOLDERING FLUX

Specify soldering flux for oscillograph galvanometers. This is furnished in 1/2-oz. bottles.

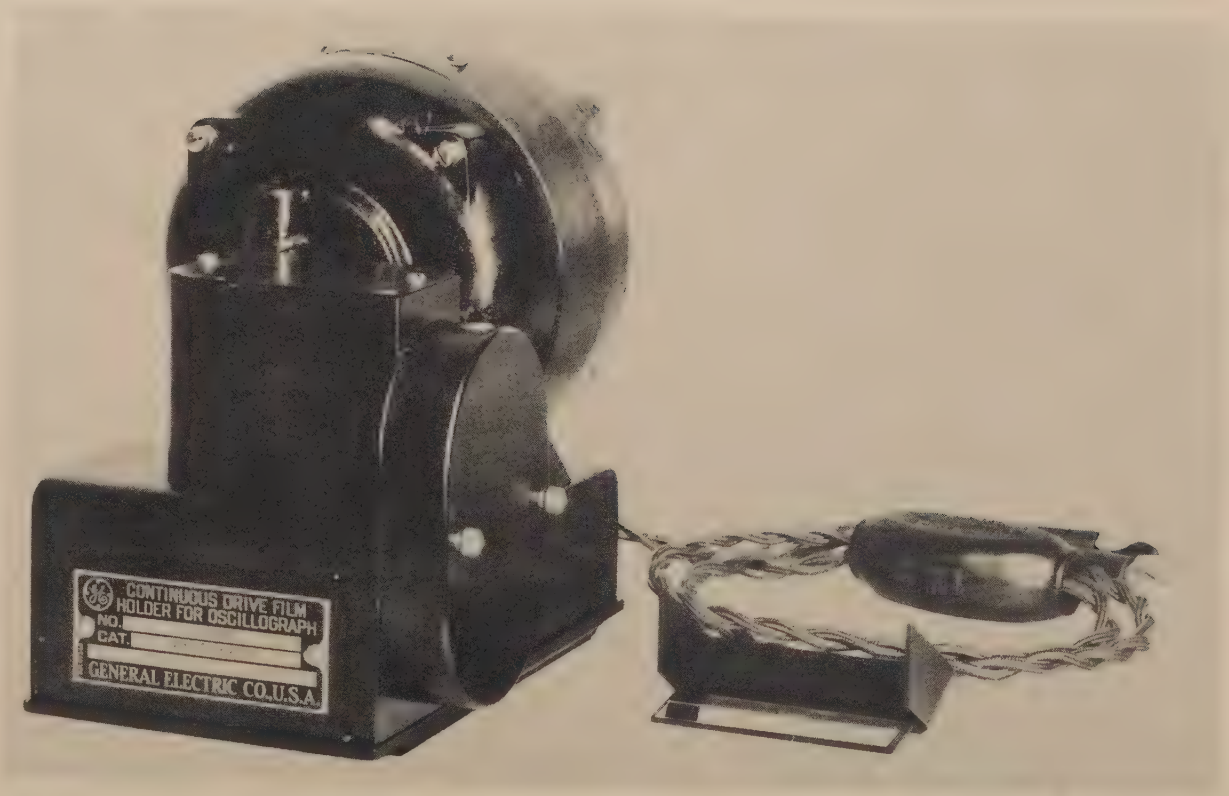

FIG. 10. CONTINUOUS-DRIVE FILM HOLDER AND MIRROR FOR TYPE PM-12-A OSCILLOGRAPH

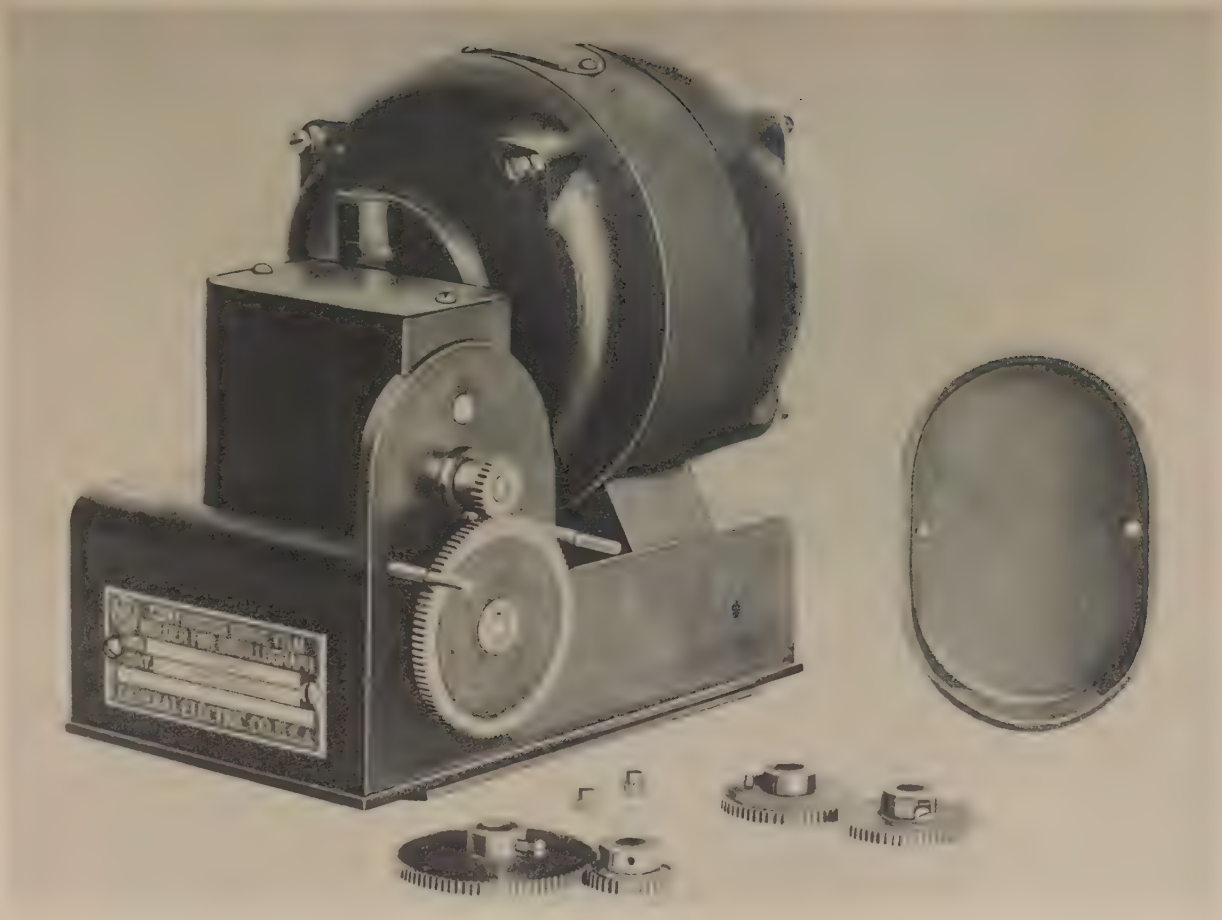

FIG. 11. CONTINUOUS-DRIVE FILM HOLDER
FOR TYPE PM-12-A OSCILLOGRAPH
VIEW SHOWING GEAR COVER REMOVED AND CHANGE GEARS

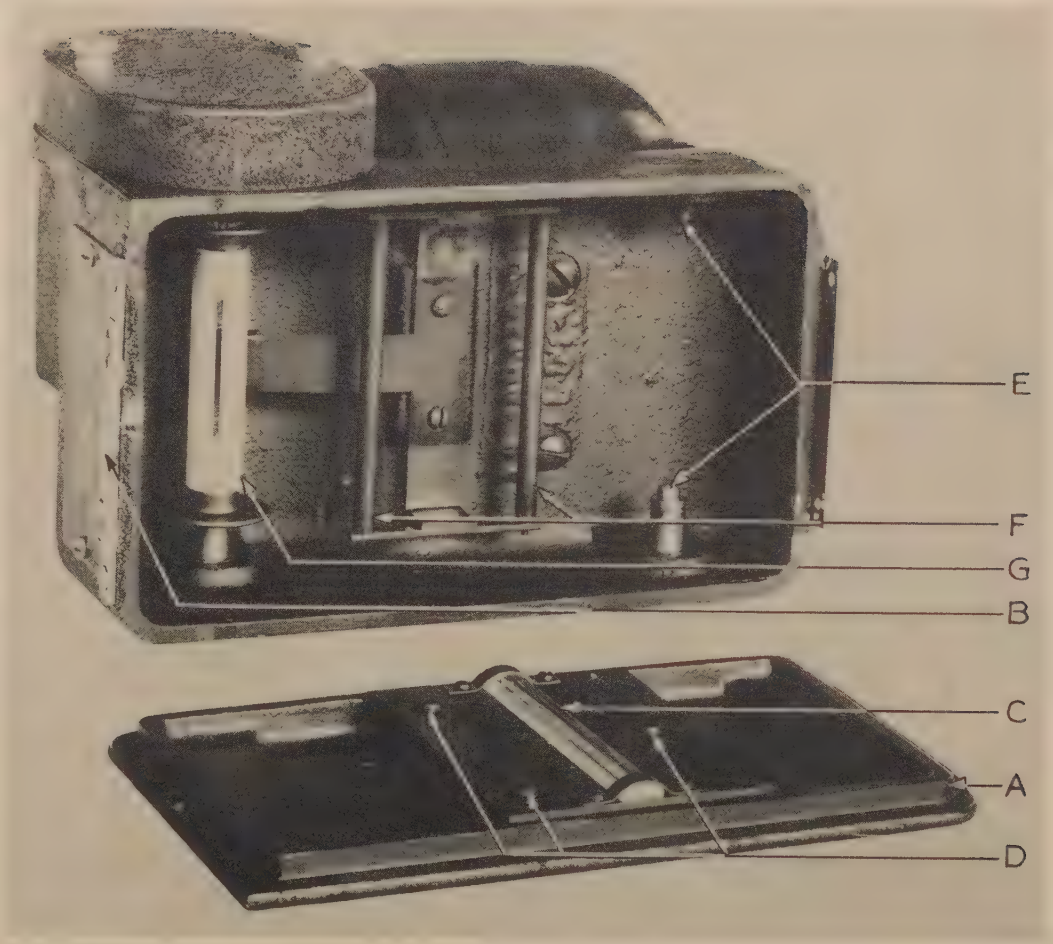

FIG. 12. CONTINUOUS-DRIVE FILM HOLDER
FOR TYPE PM-12-A OSCILLOGRAPH
BOTTOM COVER REMOVED FOR LOADING

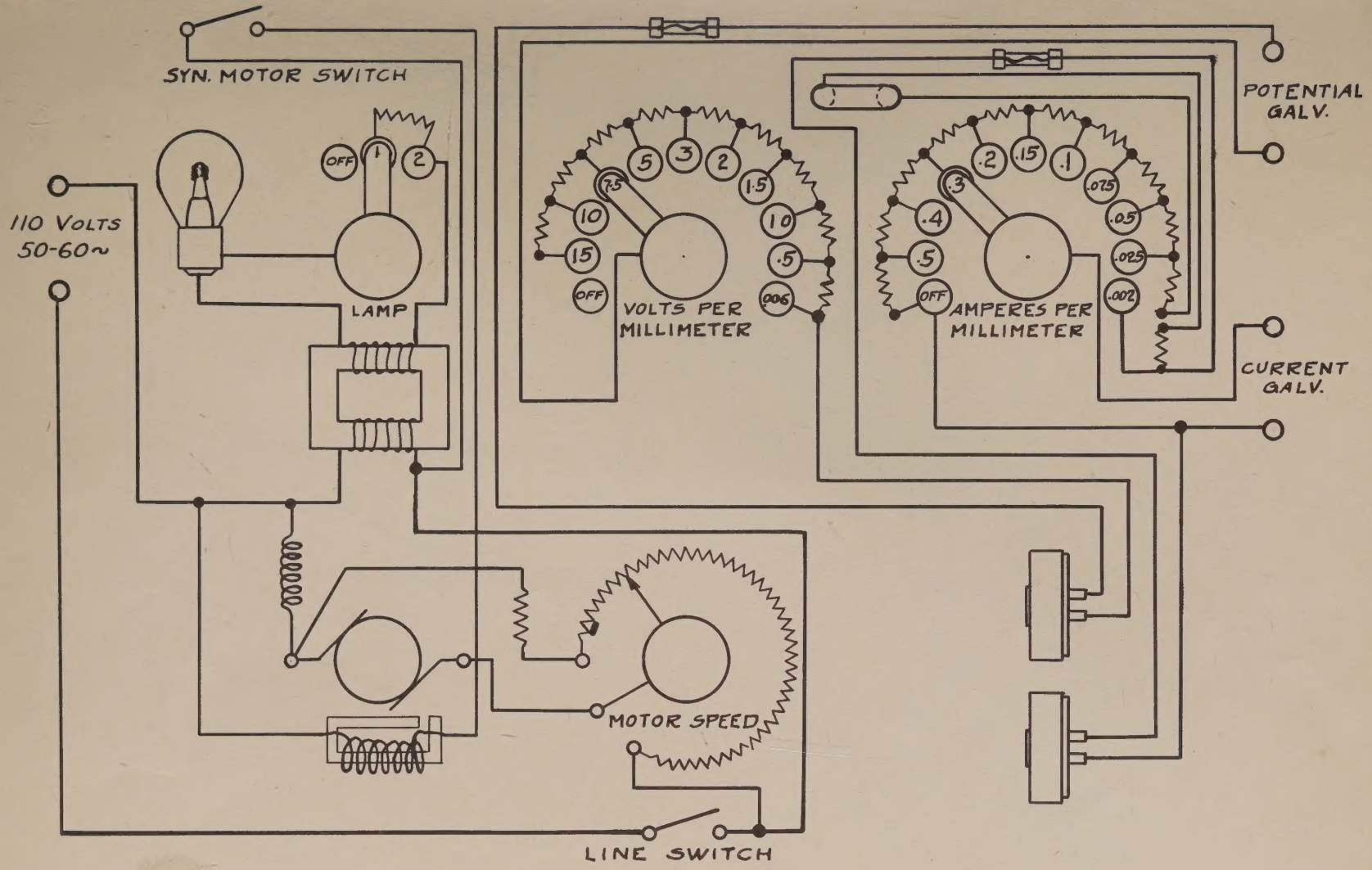

Fig. 13. Circuit Diagram of Type PM-12-A Oscillograph

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